

What is claimed is:

1. A tandem pump unit comprising:

a first hydraulic pump and a second hydraulic pump respectively having a first pump shaft and a second pump shaft respectively having adjacent ends connected together so that said first and second pump shafts are coaxially aligned and non-rotatably connected in tandem;

a common housing for accommodating said first hydraulic pump and said second hydraulic pump;

a first center section and a second center section for respectively supporting said first hydraulic pump and said second hydraulic pump;

said common housing having a first opening and a second opening respectively formed at opposed ends of said housing with respect to the pump shaft direction, and a bearing wall located between said first and second openings, said first and second openings allowing said first and second hydraulic pumps to pass therethrough ;

said first and second center sections being respectively connected to said housing so as to seal said first and second openings, with said first and second hydraulic pumps respectively supported by said first and second center sections; and

said adjacent ends of said first and second pump shafts being supported by the bearing wall of the housing.

2. A tandem pump unit according to claim 1, further comprising:

a coupler for non-rotatably receiving said adjacent ends of said first and second pump shafts.

3. A tandem pump unit according to claim 2, wherein:
said coupler is rotatably supported in a bearing hole formed in said bearing wall via a bearing member.
4. A tandem pump unit according to claim 1, wherein:
said first and second hydraulic pumps are axial piston pumps of a variable displacement type respectively having first and second angularly adjustable swash plates of a cradle type; and
said bearing wall has a side facing said first and second hydraulic pumps that forms guiding surfaces for slidably guiding spherical convex surfaces formed in rear sides of said swash plates, which rear sides are opposed to surfaces facing said first and second hydraulic pumps.
5. A tandem pump unit comprising:
the integral arrangement of a first hydraulic pump and a second hydraulic pump;
said first hydraulic pump with a first pump shaft, adapted to be connected to a first actuator via a first pair of hydraulic lines;
said second hydraulic pump with a second pump shaft, adapted to be connected to a second actuator via a second pair of hydraulic lines;
wherein said first pump shaft and said second pump shaft respectively having adjacent ends connected together so that said first and second pump shafts are coaxially aligned and non-rotatably connected in tandem;
a charge line disposed within said tandem pump unit and having a first end communicating with either a reservoir or a hydraulic fluid feeding mechanism and a second end adapted to communicate with the first pair of hydraulic lines and the second pair of hydraulic lines, respectively.

6. A tandem pump unit according to claim 5, further comprising:
a common center section having oppositely facing sides with respect to the pump shaft direction, respectively supporting said first and second hydraulic pumps via said oppositely facing sides;
a first pump housing and a second pump housing for respectively accommodating said first hydraulic pump and said second hydraulic pump;
said common center section forming a first pair of inlet/outlet ports and a second pair of inlet/outlet ports, said first pair of inlet/outlet ports respectively serving as connection ports for connection with said first pair of hydraulic lines, and said second pair of inlet/outlet ports respectively serving as connection ports for connection with said second pair of hydraulic lines; and
said charge line having a first bore portion, a conduit and a second bore portion, said first bore portion formed in a peripheral wall of either said first pump housing or said second pump housing with a first end opening to the outside of said either the first pump housing or the second pump housing so as to communicate with said either the reservoir or the hydraulic fluid feeding mechanism and a second end opening to the inside of said either the first pump housing or the second pump housing, said conduit disposed within said either the first pump housing or the second pump housing with a first end connected to the second end of said first bore portion and a second end extending to said common center section, and said second bore portion formed in the common center section with a first end connected to the second end of the conduit and a second end communicating with the first pair of inlet/outlet ports and the second pair of inlet/outlet ports, respectively.

7. A tandem pump unit according to claim 5, further comprising:

a common center section having oppositely facing sides with respect to the pump shaft direction, respectively supporting said first and second hydraulic pumps via said oppositely facing sides;

a first pump housing and a second pump housing for respectively accommodating said first hydraulic pump and said second hydraulic pump;

said common center section forming a first pair of inlet/outlet ports and a second pair of inlet/outlet ports, said first pair of inlet/outlet ports respectively serving as connection ports for connection with said first pair of hydraulic lines, and said second pair of inlet/outlet ports respectively serving as connection ports for connection with said second pair of hydraulic lines; and

said charge line having a third bore portion and a fourth bore portion, said third bore portion formed in a peripheral wall of either the first pump housing or the second pump housing with a first end opening to the outside of said either the first pump housing or the second pump housing so as to communicate with said either the reservoir or the hydraulic fluid feeding mechanism and a second end extending to the common center section, said fourth bore portion formed in the common center section with a first end connected to the second end of said third bore portion and a second end communicating with said first pair of inlet/outlet ports and said second pair of inlet/outlet ports, respectively.

8. A tandem pump unit according to claim 6, wherein:

said common center section forms a hydraulic fluid communication hole for communication between said first and second pump housings.

9. A tandem pump unit according to claim 5, further comprising:

a common pump housing for accommodating the first and second hydraulic pumps;

a first center section and a second center section for respectively supporting said first hydraulic pump and said second hydraulic pump

said common pump housing having a first opening and a second opening respectively formed at opposed ends of said pump housing with respect to the pump shaft direction, said first and second openings allowing said first and second hydraulic pumps to pass therethrough;

said first and second center sections being respectively connected to said common pump housing so as to seal said first and second openings in a liquid tight manner;

said first and second center sections respectively forming a first pair of inlet/outlet ports and a second pair of inlet/outlet ports serving as connection ports for connection respectively with the first pair of hydraulic lines and the second pair of hydraulic lines; and

said charge line having a first end opening to the outside of either said first center section or said second center section so as to communicate with said either the reservoir or the hydraulic fluid feeding mechanism, and a second end communicating with the first pair of inlet/outlet ports and the second pair of inlet/outlet ports, respectively.

10. A tandem pump unit according to claim 9, wherein:

said common pump housing has a bearing wall located between said first and second openings with respect to the pump shaft direction to support said adjacent ends of the first and second pump shafts; and

said bearing wall divides said common pump housing into a first hydraulic pump accommodation chamber and a second hydraulic pump accommodation chamber for respectively accommodating said first hydraulic pump and said second hydraulic pump.

11. A tandem pump unit according to claim 10, wherein:

said common pump housing is designed to allow hydraulic fluid to communicate between the first hydraulic pump accommodation chamber and the second hydraulic pump accommodation chamber.

12. A tandem pump unit comprising:

the integral arrangement of a first hydraulic pump and a second hydraulic pump;

said first hydraulic pump with a first pump shaft, adapted to be connected to a first actuator via a first pair of hydraulic lines;

said second hydraulic pump with a second pump shaft, adapted to be connected to a second actuator via a second pair of hydraulic lines;

wherein said first pump shaft and said second pump shaft respectively having adjacent ends connected together so that said first and second pump shafts are coaxially aligned and non-rotatably connected in tandem;

a center section supporting said first hydraulic pump and said second hydraulic pump;

a housing accommodating said first hydraulic pump and said second hydraulic pump;

wherein said first hydraulic pump, said second hydraulic pump, said center section and said housing are integrally connected together to constitute a single unit; and

a reservoir tank supportedly connected to said single unit for storing hydraulic fluid to be replenished to said first pair of hydraulic lines and said second pair of hydraulic lines.

13. A tandem pump unit according to claim 12, wherein:

said single unit is designed so that the housing can serve as a hydraulic fluid tank; and

said pump unit further comprises a hydraulic fluid communication passage for providing a free fluid communication between said reservoir tank and said housing.

14. A tandem pump unit according to claim 13, wherein:

said center section forms a first pair of hydraulic passages respectively having first ends communicating with said first hydraulic pump and second ends opening to the outside of said center section to form connection ports for connection with said first pair of hydraulic lines, a second pair of hydraulic passages respectively having first ends communicating with said second hydraulic pump and second ends opening to the outside of said center section to form connection ports for connection with said second pair of hydraulic lines, and a charging passage having a first end opening to the outside of said center section to form an inlet port for charging, serving as an inlet for the hydraulic fluid to be replenished and a second end communicating with said first pair of hydraulic passages and said second pair of hydraulic passages via check valves;

said charging passage is connected to a pressure relief line communicating with said housing via a relief valve; and

said inlet port for charging is connected to said reservoir tank via a hydraulic

fluid replenishing passage.

15. A tandem pump unit according to claim 14, wherein:

a cooling fan is provided near said single unit, said cooling fan adapted to be driven in synchronism with said first and second hydraulic pumps;

said reservoir tank is connected to said single unit in such a manner as to form a clearance therebetween into which a cooling air stream is drawn from said cooling fan; and

said hydraulic fluid communication passage and said hydraulic fluid replenishing passage are disposed in such a manner as to traverse said clearance.

16. A tandem pump unit comprising:

a first hydraulic pump and a second hydraulic pump respectively having a first pump shaft and a second pump shaft that are coaxially aligned and non-rotatably connected in tandem;

a center section supporting said first hydraulic pump and said second hydraulic pump;

a housing accommodating said first hydraulic pump and said second hydraulic pump, said housing adapted to be used as a hydraulic fluid tank;

a hydraulic fluid circulation mechanism for taking the hydraulic fluid from the hydraulic tank, and again returning the same to said hydraulic tank; and said hydraulic fluid circulation mechanism designed to cool the hydraulic fluid while circulating the same.

17. A tandem pump unit according to claim 16, wherein:

said circulation mechanism includes a circulation line, at least a portion of

which serves as a conduit, said circulation line having a first end communicating with the inside of said hydraulic tank and a second end again communicating with the inside of said hydraulic tank; and said conduit has at least a portion provided thereon with cooling fins.

18. A tandem pump unit according to claim 17, wherein:

said center section forms a first pair of hydraulic passages respectively having first ends communicating with said first hydraulic pump and second ends opening to the outside of said center section to form connection ports for connection with said first pair of hydraulic lines, a second pair of hydraulic passages respectively having first ends communicating with said second hydraulic pump and second ends opening to the outside of said center section to form connection ports for connection with said second pair of hydraulic lines, and a charging passage having a first end communicating with said hydraulic fluid tank to form an inlet port for charging, serving as an inlet for the hydraulic fluid to be replenished and a second end communicating with said first pair of hydraulic passages and said second pair of hydraulic passages via check valves; and

said pump unit further comprises:

a charge pump for sucking the hydraulic fluid stored within said hydraulic fluid tank and then discharging the same into said inlet port for charging;

a pressure relief line having a first end connected to said charging passage via a relief valve and a second end forming a drain port through which the hydraulic fluid from said relief valve is drained; and

wherein said second end of said pressure relief line is connected to

the conduit, and said charge pump constitutes a part of said hydraulic fluid circulation mechanism.

19. A tandem pump unit according to claim 17, further comprising a reservoir tank, wherein:

said reservoir tank is in free fluid communication with said housing via a hydraulic fluid communication passage, and forms a hydraulic fluid tank in cooperation with said housing; and
said inlet port for charging communicates with said reservoir tank via a hydraulic fluid replenishing passage.

20. A tandem pump unit according to claim 19, wherein cooling fins are provided on said hydraulic fluid replenishing passage and said hydraulic fluid communication passage.

21. A tandem pump unit according to claim 19, wherein:

a cooling fan adapted to be driven in synchronism with said first and second hydraulic pumps is provided near said housing;
said reservoir tank is connected to said housing in such a manner as to form a clearance therebetween, into which a cooling air stream from said cooling fan is drawn; and
said hydraulic fluid communication passage and said hydraulic fluid replenishing passage are disposed to transverse said clearance.

22. A tandem pump unit according to claim 21, wherein a cooling air duct is provided so that a cooling air stream from said cooling fan is drawn into said clearance along said cooling air duct.

23. A tandem pump unit comprising:

a first hydraulic pump including a first pump shaft with a first end and a second end;

a second hydraulic pump including a second pump shaft with a first and a second end, said second pump shaft being aligned coaxially with the first pump shaft;

a coupler for operatively connecting the first pump shaft and the second pump shaft together with the first ends thereof;

housing means forming opening means through which the first and second pumps are incorporated with said housings means;

center section means disposed so as to over said opening means of the housing means and in cooperation with said housing means form a first hydraulic pump accommodation space and a second hydraulic pump accommodation space, which respectively accommodate the first and second hydraulic pumps;

said center section means having surfaces respectively facing the first and second hydraulic pump accommodation spaces for supporting thereon the first and second hydraulic pumps, said center section means being provided with a first pair of inlet/outlet ports for the first hydraulic pump, a second pair of inlet/outlet ports for the second hydraulic pump, said first and second pairs of inlet/outlet ports being respectively open to the outside through said surfaces, and first and second hydraulic lines for respectively providing fluid connections between said first and second pairs of inlet/outlet ports;

a power input portion provided at any one of the second ends of the first and second pump shafts; and

a charge pump operatively connected with any one of the second ends of the first and second pump shafts for feeding pressurized hydraulic fluid to the first and second hydraulic lines, respectively.

24. A tandem pump unit according to claim 23, wherein:

said first and second hydraulic pump accommodation spaces are designed to store hydraulic fluid and be in free fluid communication with each other; and

said charge pump is fluidly connected with any one of the first and second hydraulic pump accommodation spaces so as to suck hydraulic fluid from said any one of the first and second hydraulic pump accommodation spaces.

25. A tandem pump unit according to claim 24, further comprising a cooling fan for cooling hydraulic fluid stored in said first and second hydraulic pump accommodation spaces, said cooling fan being operatively connected with any one of the second ends of the first and second pump shafts.

26. A tandem pump unit comprising:

- a first hydraulic pump including first pump shaft with a first end and a second end;

- a second hydraulic pump including a second pump shaft with a first and a second end, said second pump shaft being aligned coaxially with the first pump shaft;

- a coupler for operatively connecting the first pump shaft and the second pump shaft together via the first ends thereof;

- a housing having openings respectively formed at opposite ends of said housing with respect to a pump shaft direction for respectively incorporating the first and second pumps with the housing therethrough, and a bearing wall located substantially at the center of the pump shaft direction, said bearing wall forming a through hole, through which said coupler is inserted;

- first and second center sections connected with said housing so as to respectively cover said openings of the housing and in cooperation with said housing form at first hydraulic pump accommodation space and a second hydraulic pump accommodation space, which respectively accommodate the first and second hydraulic pumps;

- said first and second center sections restively having surfaces respectively facing the first and second hydraulic pump accommodation spaces for supporting thereon the first and second hydraulic pumps, said first and second center sections

being respectively provided with a first pair of inlet/outlet ports for the first hydraulic pump and a second pair of inlet/outlet ports for the second hydraulic pump, said first and second pairs of inlet/outlet ports being respectively open to the outside through said surfaces, and first and second hydraulic lines for respectively providing fluid connections between said first and second pairs of inlet/outlet ports;

a power input portion provided at any one of the second ends of the first and second pump shafts; and

a charge pump mounted on a surface of any one of the first and second center sections, which surface faces outside of the first and second center sections, so as to be operatively connected with any one of the second ends of the first and second pump shafts for feeding pressurized hydraulic fluid to the first and second hydraulic lines, respectively.

27. A tandem pump unit according to claim 26, wherein:

said first and second hydraulic pump accommodation spaces are designed to store hydraulic fluid and be in free fluid communication with each other; and

said charge pump is fluidly connected with any one of the first and second hydraulic pump accommodation spaces so as to suck hydraulic fluid from said any one of the first and second hydraulic pump accommodation spaces.

28. A tandem pump unit according to claim 27, further comprising a cooling fan for cooling hydraulic fluid stored in said first and second hydraulic pump accommodation spaces, said cooling fan being operatively connected with any one of the second ends of the first and second pump shafts.

29. A tandem pump unit according to claim 26, wherein said first ends of the first and second pump shafts are supported by the bearing wall of the housing via the coupler.

30. A tandem pump unit comprising:

a first hydraulic pump including a first pump shaft with a first end and a second end;

a second hydraulic pump including a second pump shaft with a first and a second end, said second pump shaft being aligned coaxially with the first pump shaft;

a coupler for operatively connecting the first pump shaft and the second pump shaft together via the first ends thereof;

a first housing having an opening formed at one end of the first housing with respect to a pump shaft direction for incorporating the first pump with the first housing therethrough;

a second housing having an opening formed at opposite end of the housing with respect to a pump shaft direction for incorporating the second pump with the second housing therethrough;

a center section interposed between the one end of the first housing and the opposite end of the second housing so as to cover said openings of the first and second housings and connected with the first and second housings, and in cooperation with said first and second housings form a first hydraulic pump accommodation space and a second hydraulic pump accommodation space, which respectively accommodate the first and second hydraulic pumps;

said center section having surfaces respectively facing the first and second hydraulic pump accommodation spaces for supporting thereon the first and second hydraulic pumps, said center section being provided with a first pair of inlet/outlet ports for the first hydraulic pump, a second pair of inlet/outlet ports for the second hydraulic pump, said first and second pairs of inlet/outlet ports being respectively open to the outside through said surfaces, and first and second hydraulic lines for respectively providing fluid connections between said first and second pairs of inlet/outlet ports, said center section forming a through hole, through which said coupler is inserted;

a power input portion provided at any one of the second ends of the first and second pump shafts; and

a charge pump mounted on a surface of any one of the first and second housings, which surface faces outside of the first and second center housings, so as to be operatively connected with any one of the second ends of the first and second pump shafts for feeding pressurized hydraulic fluid to the first and second hydraulic lines, respectively.

31. A tandem pump unit according to claim 30, wherein:

said first and second hydraulic pump accommodation spaces are designed to store hydraulic fluid and be in free fluid communication with each other; and

said charge pump is fluidly connected with any one of the first and section hydraulic pump accommodation spaces so as to suck hydraulic fluid from said any one of the first and second hydraulic pump accommodation spaces.

32. A tandem pump unit according to claim 31, further comprising a cooling fan for cooling hydraulic fluid stored in said first and second hydraulic pump accommodation spaces, said cooling fan being operatively connected with any one of the second ends of the first and second pump shafts.

33. A tandem pump unit according to claim 30, wherein said first ends of the first and second pump shafts are supported by the bearing wall of the center section via the coupler.

34. A pump unit for supplying oil to first and second hydraulic motors respectively connected to left and right drive wheels, comprising:

a first hydraulic pump which includes a first pump shaft operatively connected to a power source and which is fluidly connected to said first hydraulic motor through a first closed circuit;

a second hydraulic pump which includes a second pump shaft operatively connected to said first pump shaft and which is fluidly connected to said second hydraulic motor through a second closed circuit;

a housing for accommodating said first and second hydraulic pumps; and

a common charge pump which is driven by said second pump shaft and which supplies pressure oil to both said first and second closed circuit.

35. A pump unit according to claim 34, wherein a first end of said first pump shaft extends outward from said housing, said first end of said first pump shaft supports a pulley, a first end of said second pump shaft extends outward from said charge pump, and said first end of said second pump shaft supports a cooling fan.

36. A pump unit according to claim 34, wherein said first and second pump shafts are coaxially aligned, said housing includes first and second housing portions mutually connected to each other, and said first and second housing portions respectively accommodate said first and second hydraulic pumps.

37. A pump unit comprising:

a hydraulic pump having a pump shaft operatively connected to a power source;

a housing for accommodating said hydraulic pump; and

a charge pump which is connected to said housing and which is driven by said pump shaft, wherein both ends of said pump shaft extend outward from said housing and said charge pump, and

the first and second ends of said pump shaft respectively support a pulley and a cooling fan.